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Opinion

Performance Investigation of Small-World Networks for 5G Mobile Communication Networks

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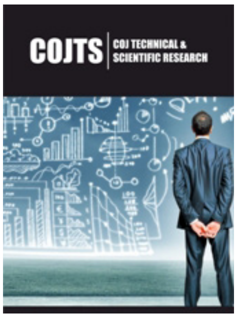

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Introduction

Due to enormous use of portable devices, private and commercial 5G mobile networks have experienced massive mobile traffic in recent years. In the near future, 5G technology will aid numerous new firms and vertical sectors, including transportation, healthcare, and the energy supply chain [1]. It is necessary for the architecture of 5G to have an extremely high level of sophistication in order to provide high-quality, uninterrupted, and dependable service to UEs that have a variety of requirements. The majority of research assumed a scale-free core network and employed Virtual Network (VN) embedding techniques [2-4]. Additionally, much research focused on acceptance and resource efficiency for performance measurement. Among them, only the deployment of VNFs differs between the methodologies used for resource allocation optimization. Moreover, almost all network slicing approaches employ a Scale-Free Network (SFN) model [5], which has limitations in determining Network Slice Request (NSR) shortest pathways. When NSRs are carefully scheduled and have a longer life, scale-free network models are less efficient. Considering the above-mentioned facts, this proposed work attempts to create a slicing-friendly infrastructure in order to maximize stakeholder advantages while using fewer facilities. This work employs Watts-Strogatz [6] Small World Networks (SWN) to create a slicing-friendly physical design.

Proposed strategy

We are aware that the operations of node provisioning and link provisioning occur sequentially and are involved in the resource allocation for the NSR nodes located in the Physical Infrastructure (PI). It is critical to ensure that the assigned nodes and links adhere to the relevant Service Level Agreements (SLAs), including those pertaining to throughput, CPU capacity, and NSR security standards. Furthermore, resource allocation should attempt to maximize revenue while also making the most efficient use of resources. In order to meet the previously described needs, this suggested study proposes a Fuzzy approach [4] for node and link provisioning using Dijkstra's algorithm. The majority of academic literature in 5G indicates that feature extraction from individual nodes is the best strategy for ranking nodes in a network. We rank nodes based on characteristics such as their CPU capacity, degree, bandwidth, and degree of centrality. It makes sense to scale these four criteria, which vary in magnitude, together before proceeding to the ranking. To meet the requirement, the fuzzy rule-based min-max scalar has built for all four parameters. After receiving the fuzzy decision arrays of both networks, the nodes of the service request network are mapped into the physical infrastructure, and the procedure is completed. As a result, the node with the highest ranking in the service request network has been merged with the node with the highest ranking in the physical infrastructure. The K shortest path algorithm is utilized to calculate the shortest path for the embedded nodes of PI, which is not explained here because much earlier research employed a similar approach for link provisioning.

Simulation results

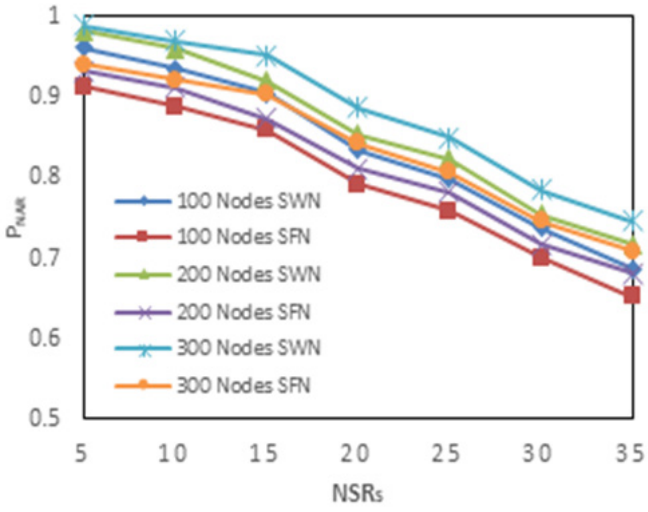

Figure 1: Resource efficiency.

In this study, the Watts–Strogatz and Barabsi–Albert models are utilized to construct the SWN and SFN. The SWN is superior to the SFN in terms of its benefits since, in contrast to the SFN, it is able to connect any two network nodes. SFN has been used for NSRs in a few studies, including [2-3]. Construction of the physical infrastructure of the SFN and SWN is currently taking place using nodes 100, 200, and 300. In a manner analogous to what was done in the past, the values for the NSR parameters are arbitrarily chosen from among a predetermined range [4]. The suggested method is evaluated using two different networks. NSRs are raised from 10 to 30, and the results of the algorithm are analyzed. The Figure 1 demonstrates that a SWN topology results in increased network slicing efficiency. When NSRs are added to a network, the resource efficiency of the network decreases. Both scenarios benefit from the increased number of infrastructure nodes, which makes operations more efficient. When 30 NSRs with less than 100 nodes are served by SFN, the resource efficiency is 0.44, but when SWN is used, it is 0.65. A network topology that is based on SWN enables better network slicing during high-demand periods while simultaneously consuming fewer resources. When given access to more resources, SWN shows improved performance. The acceptance ratio is a metric that evaluates how well an algorithm performs on a variety of network infrastructures. Figure 2 demonstrates the acceptance rate of different PI models for serving NSRs between 5 and 35 under different number of provisioning nodes (100, 200, and 300). In every scenario, the figure demonstrates an acceptance ratio that is greater than 0.9. Demand has the effect of lowering the acceptance ratio, regardless of the network topology. The provisioning that is done through the SWN, on the other hand, offers a significantly higher acceptance ratio in comparison to the provisioning done by the SFN structure under various physical nodes. Despite having a peak demand of 35 NSRs, SWN is still able to achieve an acceptance ratio of 0.68. This is because SFN only uses a small portion of the resources that are available. In addition, SWN is able to produce an acceptance ratio of 0.77 for the highest peak demand despite having increased capacity. On the other hand, SFN makes use of the same quantity of resources in order to achieve an acceptance ratio of 0.74.

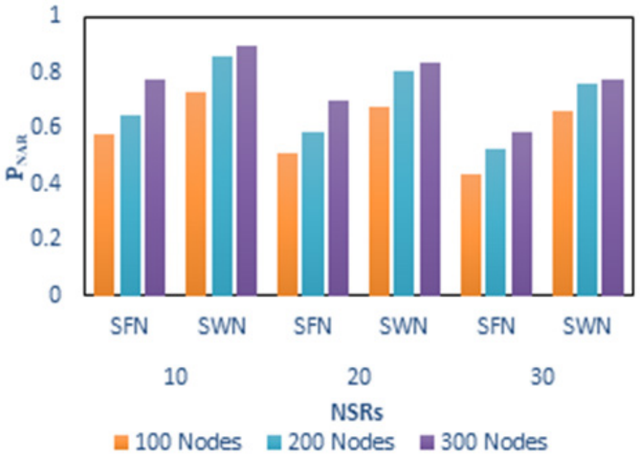

Figure 2: Acceptance rate.

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